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ABSTRACT

In this 1977 study the heart rates of 51 men and women ranging in age from 22-72 were continuously monitored while the subjects walked or ran a modified parcour fitness trail. The length of the course, its gradient, the distance between exercise stations, and the elevation of the course were measured. Mean percentage max HR (Karvonen) values were submitted to a two-factor ANOV mixed design to compare HR at each station by age and sex. Results indicate that women usually performed at a higher percentage max HR than men. Older subjects experienced potential training effects while younger ones were not always challenged. The results support the modification and use of fitness trails as an alternative exercise and fitness training method for senior adults. (Author/LH)

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Heart rates were monitored continuously while 51 men and women ranging in age from 22-72 walked or jogged a modified parcour fit trail. Subjects were required to have a treadmill stress test prior to participation. The length of the course, its gradient, distance between stations and elevation of the course were measured. Mean % max HR (Karvonen) values were submitted to a two-factor ANOV mixed design to compare HR to and at each station by sex and age. Results indicated some significant interaction effects. Women generally performed at a higher % max HR than men. Older subjects experienced potential training effects while younger subjects were not always challenged. Desired max output was exceeded in some cases. The results supported modification and use of fit trails for senior adults as a means of achieving cardiovascular fitness training effects which are perceived by participants as beneficial and offer an alternative fitness regimen.

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RUNNING HEAD:

FIT TRAIL RUNNING OF SENIOR ADULTS

PHYSIOLOGICAL RESPONSES OF SENIOR ADULTS RUNNING A FIT TRAIL[1]

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Monty L. Christiansen, M.L.A.; Gordon Blackburn, M.S.[2]

"The money a community invests in active recreation and training may provide ten-fold dividends in money saved on medical service costs." (Astrand, 1972, p. 40.) From childhood to adulthood, it has been well documented that one of the greatest correlates of good health is fitness. The road to achievement of fitness is through physical activity. Values to the human organisms of participation in a physical activity program of jogging have been shown to include improvement in fitness of the cardiovascular system, an effective modality in post-coronary care and rehabilitation, and protection against the decline in work capacity normally evident with increasing age (Clarke, January, 1977). Other research has shown that what people do for recreation and participation in later years reflects what they have done through younger and middle years (Riley, 1976). Over the past ten years or more, the vogue in activity has been exercise and jogging, starting first with men, and over

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the last five years including increasing numbers of women. This focus on fitness in the preventive sense has led to the inclusion of jogging trails all over the country and in many cases adaptation of the parcours or fit trails around the edges of golf courses, in town parks, and in various wooded areas. These courses, modeled on the Swedish Training Track, a variation of interval training in jogging designed to exercise the participant for 30 to 40 minutes, have grown to include various exercises at specified stations around the course and are graded to various levels of physiological output. However, this classification has generally been geared to a young and middle adult population, with the differentiation being made in terms of sedentary and fit participants, with some assumption that to be elderly is to be untrained. Testing of this assumption has not been extensive, and fit trails have not necessarily been planned for the 60, 65, and 70 year old with concern for level of fitness, carryover of training regimen engaged in at 45, 50, and 55 years, and interest of the retiree to do those things which are of clear value to him or her as a post work activity.

Research on fitness training and effects of exercise on HR and VO_2 max of adults has increased throughout the 1970's. Much of this research was laboratory based, with testing for physiological variables done before and after participation in specific conditioning programs. Few of the studies were field-oriented with data collected during exercise by means of telemetry. Findings of two studies by DeVries, one on men (1970) and the other on women (Adams and DeVries, 1973) established clearly: (1) the trainability of adults, (2) that this capacity does not differ greatly from that of younger people if compared on a percentage basis, and (3) that the trainability of women is

similar to that for men. These findings were confirmed by Sidney and Shephard (1978), who also cautioned the planner of exercise programs to consider the capacities and restrictions of an aging locomotor system, as well as the adults willingness to devote time to sustained exercise. This latter point leads to the question of motivation. Stoedefalke (1974), suggested that a person's adherence to an exercise program depends almost entirely on his/her motivation. This concern coupled with the fact that training is both desirable and possible, would seem to indicate that researchers and program leaders should find many different ways for adults to achieve fitness gain. The need for variety might reflect differences in preference linked to possible personality differences (Hartung and Farge, 1977; Howell and Alderman, 1967; Sidney and Shephard, 1976), health attitudes (Heinzelmann and Gabley, 1970; Sidney and Shephard, 1976), and perceptions of adults regarding how fit they are and what physical efforts are needed by them to remain fit (Sidney and Shephard). Also of importance and addressed by DeVries (1971) was the question of exercise intensity threshold necessary for improvement of cardiovascular respiratory function in older persons. DeVries indicated that 40% Heart Rate Range (HRR) for older men vs. 60% HRR for younger men resulted in potential exercise effect.

The fitness trails mentioned earlier are commercially produced and appear to be constructed on a "one size fits all" basis, with the hopes of attracting users from a variety of age groups. A literature review showed no research establishing the appropriateness for all ages of the exercises themselves, the number of exercise repetitions suggested, or the terrain of the course used. In addition, no published research was found establishing the cardio-

vascular benefit potential for members of the various age groups running the fit trail. If alternative exercise programs, available to senior adults, safe for them to use and not requiring formal leadership are to be established then research must be done to answer these and other questions. It was the purpose of this study to modify a fit trail for use by senior adults and ascertain energy costs of the exercises performed by adults locomoting the trail. Perceived exertion, telemetry capability, terrain of the trail, and the modifications of the exercises were also studied. Comparisons of heart rate (HR) were made between age groups.

METHODS AND MATERIALS

Subjects

The 53 subjects in this study (30 men and 23 women) ranged in age from 22-72 with each decade represented. All subjects, but one, perceived themselves in good health and in a good state of fitness. All subjects participated in some regular exercise. All but five of the women perceived the exertion of running the trail as comfortable; three perceived it as high and two as low. Of the men, one perceived exertion as high; four perceived it as low, and the rest thought it was comfortable. All subjects signed an informed consent form and received a copy of the exercises performed on the trail. A profile of total subjects with age, height, weight, and sex is shown in Table 1.

Instrumentation

Heart rate data were collected by means of telemetry. Walkie-talkies were used by the test team to maintain communication between the tester with the subject and the tester recording heart rate data. Temperature and humidity data were recorded at each session.

Modification of the parcour trail

The parcour fit trail at Sunset Park in State College, Pennsylvania, was the testing site for this study. Presently a standard 20 station exercise fitness trail is erected there. This particular course is 1.84 Km (.74 miles) in length with a maximum gradient mean between stations of 3.7% (difference in elevation between stations divided by distance between with no consideration for steep grades) and the minimum gradient mean between stations is 0.5%. The steepest grade is 6%. The longest distance between stations is 90.9 m and the shortest is 25.8 m. The course is 1197.4 feet (standard benchmark unit) above sea level at its highest point representing a difference in elevation of 16.1 feet.

This course is a standard one developed by the Parcour Recreational Development firm and designed for use by a general community population, usually geared to fairly young groups. Exercises are designated as beginning or advanced according to the number of repetitions suggested rather than according to the difficulty of the exercise, the position in which it is performed, or the part of the body exercised. All of these factors must be considered when dealing with an older population, so that it was determined that the exercises would have to be revised for use with senior adults, with special attention being given to inclusion of exercises for the hip flexor, abdominal, and back extensor muscles, and to consideration of the possibility of reduced flexibility in the joints as a result of aging. Particular concern was given to the shoulders and hips. In order to establish a further basis for selection of exercises, a pilot study was conducted in which three subjects in their 20's, two in their 40's, and one in his 60's were asked to run the

course, completing all of the exercises. Based on the subjects' perception of effort and comfort and the testing teams' record of actual effort expended (HR), it was decided to (1) modify or replace eleven of the original exercises, (2) re-order exercises so that muscle groups would be alternated as prime movers if the action were vigorous and (3) place milder exercises on the trail when the gradient was steeper, and include more vigorous exercises when the slope was less. A drop in HR in the middle of the course and a tapering of HR at the final two stations were planned for and anticipated.

With all of these factors in mind, exercises were chosen from Smith and Stoedefalke (1974) in which exercises are classified as of low, medium and high intensity in terms of Mets expended. In addition, a warm-up consisting of eleven exercises to take about five minutes was designed to be participated in by all subjects following taking of baseline data and prior to data collection on the fit trail. A description of the exercises used are available from the first author.

Following the choice of specific exercises, directional signs, designed to look like the original trail signs, were constructed, and were subsequently used to cover the existing signs during testing only. The newly modified trail was then re-run by the pilot subjects to verify its efficacy in terms of the specifications mentioned earlier.

Collection of the data

All data were collected in August and September, 1977. Two subjects were scheduled for each hour (2 ECG and telemetry units were available for use) from 7:00 - 9:00 a.m. during week days. No test sessions were run in the rain or when the wet bulb was over 75°. The lowest temperature was 48° (dry),

46° (wet), and the highest was 73° (dry), and 71° (wet). The smallest difference between the two was 1° and the largest difference was 4°. All subjects were given a treadmill stress test and physical at the Noll Human Performance Laboratory using the Lab medical personnel and standard procedures.

Treatment of data

All heart rate data were converted to % max HR using the Karvonen formula. A two-factor analysis of variance mixed design was used to compare mean % max HR to and at each station and for recovery, for each sex as a group across age groups. Because this technique required equal N's, all groups were equalized to four subjects per group, which necessitated combining the 60 and 70 year groups for men and dropping the 60-70 year group for women. (Total N for analysis was 36. A profile of these S's is presented in Table 2.) A .05 level of significance was set for acceptance of difference. Multiple comparisons of sample means were made using the Wholey Significant Difference (WSD) procedure.

These data for % max HR at and to each station and for recovery by sex for each age group were also plotted on a graph, with the parcour course being designated in metres x 10' with each station indicated.

RESULTS

The data analysis is presented here in terms of analysis of variance for Karvonen % max HR for each sex across age groups to and at each station on the parcour course. WSD results are presented following each section when a significant F is indicated.

Comparison of % max HR for males

Significant interaction effects were found for males between age groups and between stations on the fit trail for each age group.

Between groups by station.--Application of the WSD procedure showed that significant differences existed between % max HR of the oldest group and all of the other groups. Specifically, HR's were significantly higher for the 60-72 year age group than for the 30-39 year age group for stations 11, 15, 17, 20 and recovery; and greater than the 20-29 year age groups for station 20 and recovery. Heart rates were significantly lower for the 20-29 and 30-39 year age groups than for the other three age groups at station 20 and for the recovery period. All other comparisons between age groups by station were not significant.

Between stations for each age group.--The number of comparisons made in this WSD analysis is extensive and detailed presentation of the results of each one is prohibitive here. However, it can be observed that in general for each age group a difference in % max HR of approximately 15% HR or more resulted in a significant difference regardless of age group.

Comparison of % max HR for females

Between groups by station.--No significant interaction effects or main effects were found for females between age groups by station.

Between stations for each age group.--Results of this analysis indicated a significant F for the comparison of performance of females between stations for each age group. Application of the WSD procedure indicated that a % HR difference of 6-8 percent or more resulted in a significant difference.

Course characteristics and subject performance

The % max HR for both males and females for each station was examined in order to establish whether or not potential training effects were present, whether desired % max was exceeded, and at what stations these various effects were found. Although HR's were assessed for subjects both going to and at the exercise stations, the effects of the former were still present in the latter and therefore it would be inappropriate to treat them as though they were independent measures. The mean % max HR (Karvonen) range for men was 32 to 89% and for women was 43 to 87%. Women as a whole performed at a higher % max HR for the course. The older subjects experienced potential training effects at all stations on the course. The desired % max HR was exceeded by the women for station 18 where the S's were required to hop twice on alternate feet while swinging the arms and the other leg sideward and for the approach to 19. For the men, the desired % max HR was only exceeded by the 60-72 year age group at stations 17, 18, and 19. Station 17 was the crab balance. These data are shown in Figures 1 and 2. Peak % max HR of 100 percent were reached by at least one male in the 50-59 year age group and the 60-72 year age group. For females, 100% max HR was reached by at least one woman in age groups 20-29 years and 40-49 years. As with the mean HR for the groups, individual peak HR's exceeding 90% max occurred from stations 17 to 19; with the exception of station 7 for the 30-39 year age males. This station follows the greatest incline on the course.

DISCUSSION

In assessing the results of this study, it is important to note that each subject was asked to run the fitness trail at his or her own pace. People

using fitness trails generally do set their own paces, and it was desirable here for the subjects to exercise as they usually would regardless of the testing parameters. Given that fact, it can be observed that a significant finding of this study was that the older adults tested experienced HR's at a level which could potentially produce training effects.

In light of the fact that some subjects at some stations on the course reach 100% max HR and that the means for some age groups for other individual stations exceeded 85% max HR suggests that these stations be looked at carefully in terms of placement on the course and difficulty of exercise. Since the investigators were not able to separate course gradient effects from exercise stations effects per se, both parameters need to be considered. In this regard, attention must be given to an evident "back to the barn" phenomenon which was present. The investigators had planned for a tapering off of HR at the final stations of the course, and had put a posture and a board walking exercise there. This tapering effect was not only not realized, but also the desired max HR was exceeded by all the women and the older men. The gradient after station 18 is slightly uphill and continues as such to the end of the course, but it did not appear to be enough to cause the effect noted. However, speeding up as the end came in sight was observed in most subjects. For older people, this might signal a need to plan for a required slow down to a walk as that point in the course was approached, since putting in easy exercises did not seem to be enough adaptation.

For the men, a significant difference in HR for the 60-72 year age group was found for the sit-up, the push-away from a standing lean, the crab balance and the balance walk at the end. The latter result was discussed above; the

crab balance is the beginning of the last phase of the trail, and for the other two exercises, the HR did not exceed the desired maximum of 85%. It is interesting to note that there were no significant differences in HR response between age groups for the women for any of the exercises. Overall, in looking at the pattern of HR response for the whole trail, the HR dropped, as expected, when the gradient dropped, and that on this particular trail the HR drop was noted for all groups for both sexes, for stations 9-11, located halfway through the distance of the course on the flattest part of the course. It may be that in planning exercises for the 20-50 year age groups, more difficult exercises should be included, and that for all runners easier exercises should be placed after the most incline. In the flat places the stations could be farther apart. The fact that the 20-29 year age females generally performed at a higher HR rate than the other age groups, and that the 20-29 year age males performed at a rate higher than the 30-39 year age group may be explained by the fact that generally (but not always) the youngest groups performed the task the fastest. For the men, the mean % max HR for the 30-39 year age men for six of the stations in the middle of the course did not reach 50% of max, which would indicate that the rate they elected to run the course was not demanding enough for them. However, a heart rate sufficient to produce training effects could be obtained by either increasing the number of repetitions of the specific exercise (duration) or increasing the speed in which they were performed (intensity).

In light of the findings of this study, the researchers would recommend the use of modified fit trails for senior adults, with the provision that the suggestions regarding the planned tapering of effort at the end of the course

be followed. Not only did the subjects derive training effects from the performance of the activities on the trail, but also they did not perceive it as requiring high exertion. Furthermore, their perceptions of their exertions were quite accurate. In addition they appeared to enjoy the variety, the challenge, and the camaraderie of participating in the trail run with others.

More research needs to be conducted which would have application for course parameters such as gradient, distances between stations and total length of the course in relation to physiological output and actual energy expenditure at the exercise stations. Now that some preliminary data are available on the age span 20-70 forming a basis for hypothesis formulation, more attention needs to be devoted to the age groups 55-75. In terms of data collection, the use of telemetry with a walkie-talkie intertester communication system proved most effective for gathering HR data in a field situation.

SUMMARY

Fifty-three subjects ranging in age from 22-72, with each decade represented by both men and women, were asked to walk or jog a modified parcour fit trail at their own rate while their HR's were monitored continuously. Blood pressures were taken prior to and following the run and during recovery. A treadmill stress test and physical were required of all subjects. The length of the course, maximum and minimum gradient, the distance between stations and elevation of the course were all measured. Following testing all subjects were asked how stressful they perceived their exertion to have been. Mean % max HR (Karvonen) values were submitted to a two-factor ANOV mixed design to compare HR to and at each station on the course for each sex as a group across age groups.

Results indicated significant interaction effects for males but not females between age groups and between stations for each age group for both sexes. Women as a whole performed at a higher % max HR for the course than the men. Older subjects experienced potential training effects at all stations on the course, with the younger subjects not challenged enough at some stations. Desired % max HR was exceeded for some subjects at some stations. A "back to the barn" phenomenon was evident with most subjects speeding up at the end of the course, negating the planned tapering effect.

The results supported the modification and use of fit trails for senior adults as a means of achieving cardiovascular fitness training effects which are perceived by the participants as beneficial and provides them with an alternative fitness regimen which provides variety, challenge and camaraderie with others.

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TABLE 1. PHYSICAL CHARACTERISTICS OF SUBJECTS

SUBJECTS	n	Height (cm) $\bar{x}$	S.D.	Weight (Kg) $\bar{x}$	S.D.
MALES					
20 - 29 years	5	181.1	± 4.1	77.1	± 13.6
30 - 39 years	5	179.3	± 5.3	74.3	± 6.6
40 - 49 years	5	185.4	± 5.5	80.0	± 10.0
50 - 59 I years	5	173.5	± 7.6	72.5	± 8.2
50 - 59 II years	4	182.0	± 5.6	83.8	± 3.8
60+ years	6	177.2	± 5.6	77.0	± 7.3
FEMALES					
20 - 29 years	5	163.3	± 2.8	57.2	± 11.5
30 - 39 years	5	165.9	± 6.9	61.2	± 9.0
40 - 49 years	5	162.3	± 6.8	58.7	± 9.5
50 - 59 years	5	165.1	± 6.8	62.5	± 8.9
60+ years	3	161.7	± 8.9	54.4	± 5.3

TABLE 2. CHARACTERISTICS OF PARCOUR COURSE SUBJECTS UTILIZED IN ANALYSIS OF VARIANCE

SUBJECTS	n	MEAN HEIGHT (cm)	MEAN WEIGHT (kg)	MEAN MAX VO_2 (ml/kg/min)	MEAN RUNNING TIME (min)	MEAN EXERCISING HEART RATE (% of Max)
MALES						
20 - 29 years	4	182.6 ± 2.6	80.3 ± 13.4	53.7 ± 3.9	15.5 ± 2.5	60.8 ± 14.2
30 - 39 years	4	179.1 ± 6.0	73.8 ± 7.5	46.5 ± 5.5	17.4 ± 2.2	55.7 ± 7.0
40 - 49 years	4	184.8 ± 6.3	81.3 ± 10.2	46.7 ± 5.9	14.8 ± 3.5	62.3 ± 7.0
50 - 59 years	4	177.2 ± 9.1	74.1 ± 4.1	40.4 ± 2.5	17.2 ± 1.1	66.0 ± 13.0
60 - 72 years	4	180.0 ± 4.5	76.1 ± 9.4	31.2 ± 6.3	18.6 ± 2.7	72.8 ± 13.2
FEMALES						
20 - 29 years	4	163.5 ± 3.2	52.8 ± 6.5	44.8 ± 5.8	14.9 ± 1.0	73.0 ± 13.6
30 - 39 years	4	166.7 ± 7.7	60.9 ± 10.4	40.6 ± 8.5	17.1 ± 0.5	69.9 ± 6.9
40 - 49 years	4	162.3 ± 7.8	60.7 ± 9.8	33.5 ± 9.0	18.7 ± 1.2	68.3 ± 14.1
50 - 59 years	4	166.7 ± 6.7	59.4 ± 6.5	33.2 ± 5.3	18.2 ± 1.8	71.3 ± 5.7

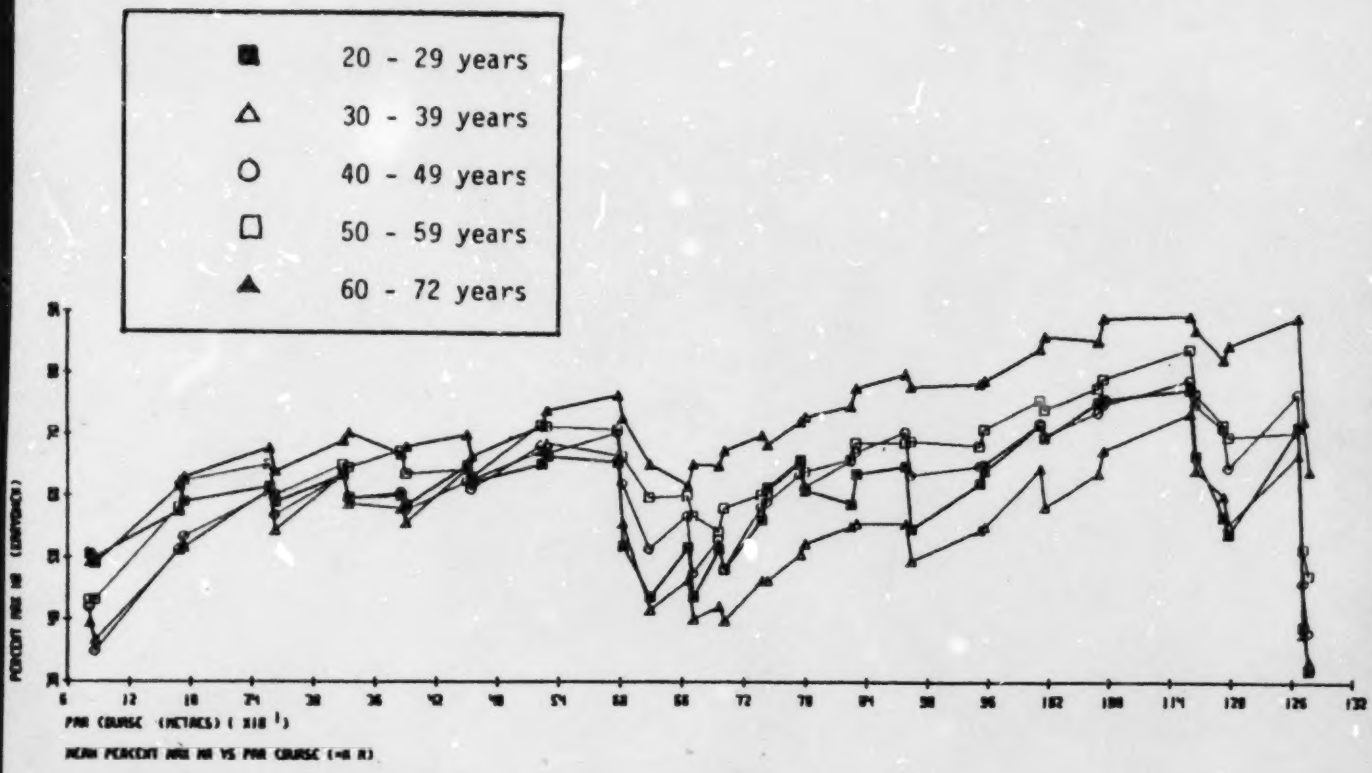

FIGURE 1

MEAN % MAX HR (KARVONEN) FOR MALES TO AND AT PARCOUR COURSE STATIONS AND RECOVERY

(N=4 per group)

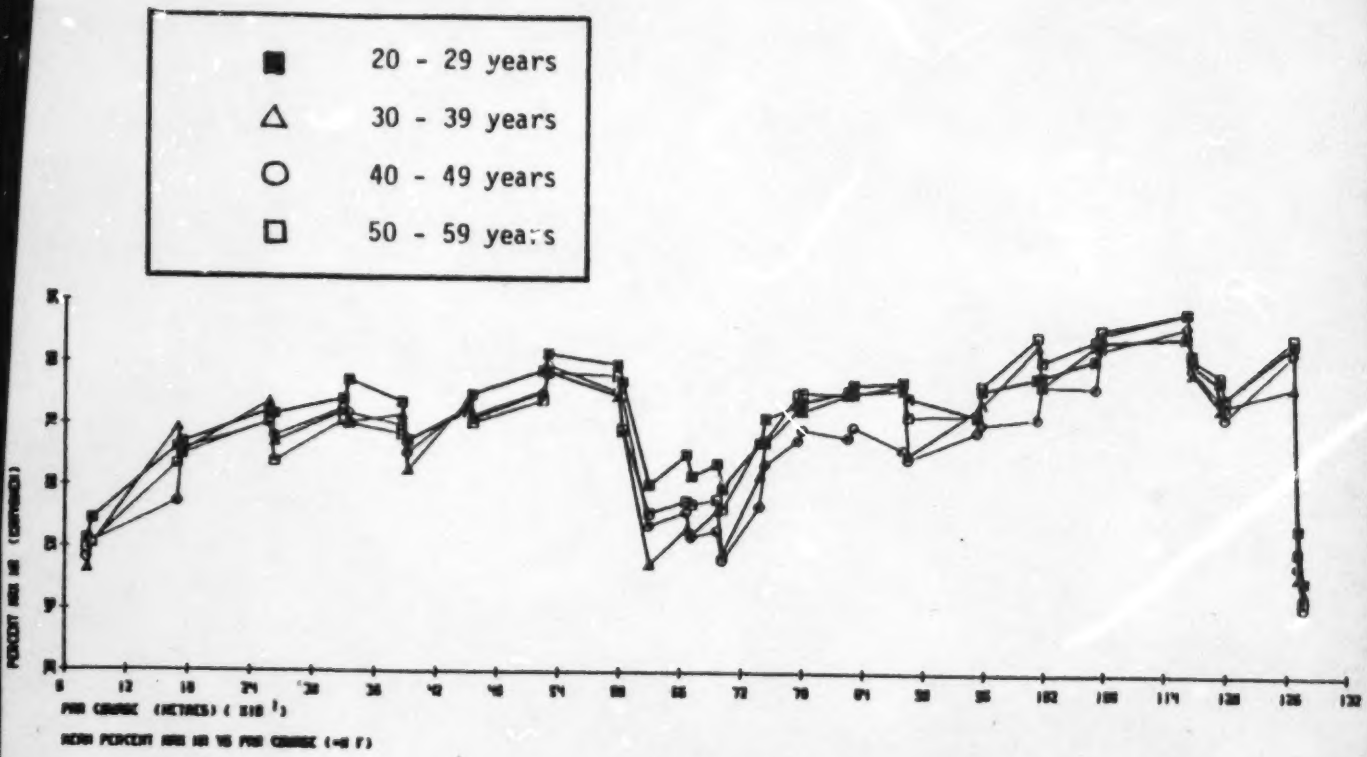

FIGURE 2

MEAN % MAX HR (KARVONEN) FOR FEMALES TO AND AT PARCOUR COURSE STATIONS AND FOR RECOVERY

(N=4 per group)

TABLE 3. COMPARISONS OF % MAX HR (KARVONEN) BY AGE GROUPS BY PARCOUR COURSE STATIONS FOR MALES (ANOVR)

SOURCE	df	SS	MS	F	p[a]
Between Subjects					
A[b]	4	30121.39	7530.35	1.429	0.273
Error	15	79043.08	5269.54		
Within Subjects					
J[c]	41	67112.38	1636.89	48.435	0.001*
AJ	164	11233.01	68.49	2.027	0.008*
Error	615	20784.42	33.80		

* Significant at or beyond the .05 level.

[a] Lambda Hat Adjustment used.

[b] Age groups.

[c] Treatments (stations).

TABLE 4. COMPARISONS OF % MAX HR (KARVONEN) BY AGE GROUPS BY PARCOUR COURSE STATIONS FOR FEMALES (ANOVR)

SOURCE	df	SS	MS	F	p[a]
Between Subjects					
A[b]	3	2101.33	700.44	0.140	0.934
Error	12	59998.57	4999.88		
Within Subjects					
J[c]	41	71242.66	1737.63	70.306	<0.000*
AJ	123	3392.61	27.58	1.121	0.349
Error	492	12108.18	24.61		

* Significant at or beyond .05.

[a] Lambda Hat Adjustment used.

[b] Age groups.

[c] Treatments (stations).